CLAIMS

1. An acceleration sensor calibration and evaluation method comprising:

attaching a strain gauge (25) to a side surface of a metal rod (1) and affixing an acceleration sensor (23) to be calibrated and evaluated to one of end surfaces (22) of the metal rod;

impacting a plurality of projectiles (3) against the other of the end surfaces (2) of the metal rod to generate an elastic wave pulse in the metal rod;

taking as an input signal to an acceleration sensor and a strain gauge, dynamic displacement, velocity or acceleration in a direction normal to the other end surface arising in a process of the elastic wave pulse generated at the other end surface of the metal rod reaching and being reflected by the one end surface where the acceleration sensor is affixed;

measuring the input signal with the acceleration sensor and the strain gauge;

processing measurement values of the strain gauge to obtain an acceleration; and

comparing the acceleration with an output of the acceleration sensor.

2. The acceleration sensor calibration and evaluation method according to claim 1, further comprising, in addition to processing measurement values of the strain gauge (25), error-correcting a strain gauge output based on elastic wave theory.

3. An acceleration sensor calibration and evaluation method comprising:

affixing an acceleration sensor (23) to be calibrated and evaluated to one of end surfaces (22) of a metal rod (1);

locating a laser interferometer (24) that irradiates the one end surface of the metal rod with a laser beam;

impacting a plurality of projectiles (3) against the other of the end surfaces (2) of the metal rod at prescribed time intervals to generate an elastic wave pulse in the metal rod;

taking as input signals to the laser interferometer and the acceleration sensor, dynamic displacement, velocity and acceleration in a direction normal to the other end surface arising in a process of the elastic wave pulse generated at the other end surface of the metal rod reaching and being reflected by the one end surface where the acceleration sensor is affixed;

measuring any one of said input signals with the acceleration sensor and the laser interferometer;

processing measurement values of the laser interferometer to obtain an acceleration; and

comparing the acceleration with an output of the acceleration sensor.

4. An acceleration sensor calibration and evaluation method comprising:

attaching a strain gauge (25) to a side surface of a metal rod (1) and affixing an acceleration sensor (23) to be calibrated and evaluated to one of end surfaces (22) of the metal rod;

locating a laser interferometer (24) that irradiates said metal rod one end surface with a laser beam;

impacting a plurality of projectiles (3) against the other of the end surfaces (2) of the metal rod to generate an elastic wave pulse in the metal rod;

taking as input signals to the strain gauge, the laser interferometer and the acceleration sensor, dynamic displacement, velocity and acceleration in a direction normal to the other end surface arising in a process of the elastic wave pulse generated at the other end surface of the metal rod reaching and being reflected by the one end surface where the acceleration sensor is affixed;

processing measurement values of the strain gauge to obtain an acceleration;

measuring any one of said input signals with the strain gauge, the acceleration sensor and the laser interferometer;

processing measurement values of the strain gauge to obtain an acceleration;

using a correction function relating to dynamic characteristics of the strain gauge based on measurement values of the laser interferometer to correct the acceleration obtained by the strain gauge processing; and

comparing the corrected acceleration with an output of the acceleration sensor.

5. The acceleration sensor calibration and evaluation method according to claim 4, further comprising, in addition to the step of processing measurement values of the strain gauge (25), error-correcting an output of the strain gauge based on elastic wave theory.

6. The acceleration sensor calibration and evaluation method according to any one of claims 1 to 5, wherein calibration and evaluation of the acceleration sensor (23) are performed by measuring any of gain-frequency characteristics, phase-frequency characteristics and peak sensitivity of the acceleration sensor in respect of any of dynamic displacement detection function, velocity detection function and acceleration detection function of the acceleration sensor.

7. The acceleration sensor calibration and evaluation method according to any one of claims 1, 2, 4, 5 and 6, wherein the strain gauge comprises a plurality of strain gauges (25) attached to the side surface of the metal rod (1) in an axial direction, and further comprising converting differences in phase caused by differences in attachment position in the axial direction to a one-point measurement result, with respect to outputs of the strain gauges (25), based on wave propagation theory, to perform signal processing to reduce strain gauge signal noise.

8. An acceleration sensor calibration and evaluation apparatus comprising:

a metal rod (1) on which is fixed at one of end surfaces (22) thereof an acceleration sensor (23) to be calibrated and evaluated;

a strain gauge (25) attached to a side surface of the metal rod;

a projectile launch means (14) that impacts the other of the end surfaces (2) of the metal rod with a plurality of projectiles (3) at prescribed time intervals to generate an elastic wave pulse in the metal rod;

the acceleration sensor and the strain gauge being for measuring as input signals any of dynamic displacement, velocity and acceleration in a direction normal to the other end surface arising in a process of the elastic wave pulse generated by the impact of the projectiles reaching and being reflected by the one end surface where the acceleration sensor is affixed; and

a signal recording/processing apparatus (26) that processes measurement values of the strain gauge to obtain acceleration and compares the acceleration with an acceleration sensor output to calibrate and evaluate the acceleration sensor.

9. The acceleration sensor calibration and evaluation apparatus according to claim 8, further comprising processing means that in addition to processing measurement values of the strain gauge (25) carries out error correction of strain gauge output based on elastic wave theory.

10. An acceleration sensor calibration and evaluation apparatus comprising:

a metal rod (1) on which is fixed at one of end surfaces (22) thereof an acceleration sensor (23) to be calibrated and evaluated;

a laser interferometer (24) that irradiates said metal rod one end surface with a laser beam;

a projectile launch means (14) that impacts the other of the end surfaces (2)

of the metal rod with a plurality of projectiles (3) at prescribed time intervals to generate an elastic wave pulse in the metal rod;

the acceleration sensor and the laser interferometer being for measuring as input signals any of dynamic displacement, velocity and acceleration in a direction normal to the other end surface arising in a process of the elastic wave pulse generated by the impact of the projectiles reaching and being reflected by the one end surface where the acceleration sensor is affixed; and

a signal amplification/recording/processing apparatus (26) that processes measurement values of the laser interferometer to obtain acceleration and compares the acceleration with acceleration sensor measurement values to calibrate and evaluate the acceleration sensor.

11. An acceleration sensor calibration and evaluation apparatus comprising:

a metal rod (1) on which is fixed at one of end surfaces (22) thereof an acceleration sensor (23) to be calibrated and evaluated;

a strain gauge (25) attached to a side surface of the metal rod;

a laser interferometer (24) that irradiates the metal rod one end surface with a laser beam;

a projectile launch means (14) that impacts the other of the end surfaces (2) of the metal rod with a plurality of projectiles (3) at prescribed time intervals to generate an elastic wave pulse in the metal rod;

the acceleration sensor, the strain gauge and acceleration sensor being for measuring as input signals any of dynamic displacement, velocity and acceleration in a direction normal to the other end surface arising in a process of the elastic wave pulse generated by the impact of the projectiles reaching and being reflected by the one end surface where the acceleration sensor is affixed; and

a signal amplification/recording/processing apparatus (26) that processes strain gauge measurement values to obtain acceleration, uses a correction function relating to dynamic characteristics of the strain gauge to correct the acceleration obtained by processing a signal from the strain gauge, based on measurement values of the laser interferometer, and compares the corrected acceleration with an output of the acceleration sensor to calibrate and evaluate the acceleration sensor.

12. The acceleration sensor calibration and evaluation apparatus according to claim 8, further comprising processing means that in addition to processing measurement values of the strain gauge (25) carries out error correction of strain gauge output based on elastic wave theory.

13. The acceleration sensor calibration and evaluation apparatus according to any one of claims 8 to 12, wherein the apparatus (26) measures any of gain-frequency characteristics, phase-frequency characteristics and peak sensitivity of the acceleration sensor in respect of any of dynamic displacement detection function, velocity detection function and acceleration detection function of the acceleration sensor.

14. The acceleration sensor calibration and evaluation apparatus according to any one of claims 8, 9, 11, 12 and 13, wherein the strain gauge (25) comprises a plurality of strain gauges attached in an axial direction on the side surface of the metal rod, and further comprising a noise reduction means that converts differences in phase caused by differences in attachment position in the axial direction to a one-point measurement result, with respect to outputs of the strain gauges (25), based on wave propagation theory, to perform signal processing to reduce strain gauge signal noise.

15. The acceleration sensor calibration and evaluation apparatus according to claim 14, wherein the strain gauge (25) comprises a plurality of strain gauges attached in an axial direction on the side surface of the metal rod and a plurality of attached strain gauges disposed in a circumferential direction.

16. The acceleration sensor calibration and evaluation apparatus according to claim 15, further comprising signal processing means that converts differences in phase caused by differences in attachment position in the axial direction to a one-point measurement result, with respect to outputs of the plurality of strain gauges (25), based on wave propagation theory, to perform signal processing to reduce strain gauge signal noise.

17. The acceleration sensor calibration and evaluation apparatus according to any one of claims 8 to 16, wherein the projectile launch means (14) has a plurality of round, concentric projectiles located on inner and outer portions of a launch tube (7).

18. The acceleration sensor calibration and evaluation apparatus according to claim 17, wherein the launch tube (7) is a round, concentric multiple launch tube and has a plurality of round, concentric projectiles (8, 10, 12) in a space between a center launch tube inner portion and each launch tube.

19. The acceleration sensor calibration and evaluation apparatus according to claim 17, wherein the projectile launch means (14) includes a launch controller that launches a plurality of projectiles independently at prescribed time intervals.

20. The acceleration sensor calibration and evaluation apparatus according to claim 17, wherein the launch tube (7) has a surface treated to reduce

friction with the projectiles.

21. The acceleration sensor calibration and evaluation apparatus according to any one of claims 8 to 21, wherein the metal rod (1) is a round rod.

22. The acceleration sensor calibration and evaluation apparatus according to any one of claims 8 to 21, wherein the projectiles (3) have tips provided with members of a different material from that of a projectile body, or wherein the projectile body is given a laminated structure comprised of different materials to adjust a frequency band of the elastic wave pulse generated in the metal rod by impact of the projectiles.

23. The acceleration sensor calibration and evaluation apparatus according to any one of claims 8 to 22, wherein in accordance with Skalak's analytic solution in elastic wave theory, when obtaining a transient strain signal forming strain gauge input from the strain of an elastic wave pulse signal incident on the other end surface, at least a primary term of a series expanded Skalak's analytic solution is used, or, to further improve precision, up to a high-order term of a Skalak's analytic solution is used.

24. The acceleration sensor calibration and evaluation apparatus according to any one of claims 8 to 23, wherein the other end surface of the metal rod (1) has a contact metal ball and the projectiles are impacted against the metal ball.